ACP Technology

Amorphous Calcium Phosphate forming Fluoride Varnishes

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Rapid Remineralization

with ACP (Amorphous Calcium Phosphate)

- Repair and Prevent Cavity by Replacing Lost Enamel with ACP
- Fill and Obstruct Dentin Tubules with ACP
- ACP Converts to Tooth Mineral

Illustration by Jeffrey Aarons

Obstruction of Dentin Tubules after 2 Minute Treatment
Formation and Conversion of Amorphous Calcium Phosphate (ACP)

\[ 3 \text{CaCl}_2 + 2 \text{K}_3\text{PO}_4 \rightarrow \text{Ca}_3(\text{PO}_4)_2 + 6 \text{KCl} \]

ACP

Tooth Mineral (Apatite)

Fast

very slow

in situ transformation
Why ACP?

- Fastest formation and dissolution
- Solid solution: Incorporate other beneficial ions readily.
- Therapeutic agents and also as the carrier for long term releases
- Transform to apatite: Put back loss tooth mineral.
- One ACP unit is 0.9 nanometer: Fill and obstruct dentin tubules and prevent the dentin hypersensitivity
- Easy to prepare and apply
Application and Delivery Vehicles

1. Solution
2. Varnish
3. Gel
4. Toothpaste
5. Prophylaxis Paste
6. Composite
7. Tooth Mousse
8. Chewing gum
9. Candy
10. Mouth Rinse
11. Dental Floss
Applications of calcium & phosphate solutions
Applications of calcium & phosphate solutions on Etched Dentin Surface

before

after
Fluoride Varnish with ACP
Dentin Surface treated with ACPF varnish

before

after
Releases from ACPF varnish

Fluoride Release

Time (min)

F (ppm)

Ca/P/F varnish

F varnish
Enamel F uptake treated with Varnishes

![Bar graph showing comparison of F uptake between 5%F and ACP+5%F]

- 5%F: 1833 ppm
- ACP+5%F: 3770 ppm

ADA Foundation
Dental Education | Access to Care | Research | Charitable Assistance
Results of ACP Technology

- **Remineralize the tooth:** Put back the tooth mineral and increase the hardness.
- **Increase fluoride efficacy:** more release and more uptake
- **Obstruct the dentin tubules:** Decrease hypersensitivity.
Next Generation ACPs
Multifactorial Etiology and Multimodal Intervention

- Diet
- Host (micro flora)
- Tooth

Caries
2nd Generation ACP Multimodal Intervention

- ACPF Varnish with Chlorhexidine: Antimicrobial and Remineralizing
- ACPF Varnish with Arginine/Chlorhexidine: Antiacidic, Antimicrobial and Remineralizing
Release, Precipitation & Hydrolysis from ACPFX Varnish

**ACPFX Varnish**

**Release**

\[ \text{Ca}^{2+} + \text{X}^{2+} + \text{(HPO}_4\text{)}^{2-} + \text{F}^- \]

**Precipitation**

\[ \text{CaF}_2 + \text{Ca}_9\text{X(PO}_4\text{)}_6\text{F}_2 \text{ (ACXPF)} \]

**Hydrolysis & Release**

\[ \text{Ca}_{10} \text{(PO}_4\text{)}_6\text{F}_2 + \text{F}^- + \text{(H}_{1.5}\text{PO}_4\text{)}^{1.5-} + \text{OH}^- + \text{X}^{2+} \]

Tooth Mineral
Releases of Ca, X, P & F from ACPFX Varnish

[Graph showing the release of Ca, P, X, and F over time (Hr) in mM]
Antimicrobial inhibition rings of varnishes containing chlorhexidine (X)
Conclusion

- ACP Technology is able to remineralize the tooth in clinical applications.
- ACP can incorporate and deliver beneficial ions: F, Chlorhexidine, and Arginine.
- Varnish readily deposit ACPs which act as therapeutic agents and also as the carriers for long term releases.
- Some Products are ready for clinical study.
ACP Products with Multiple Therapeutic Agents and delivery vehicles

- ACP varnish containing F
- ACP varnish containing F and X
- ACP Varnish containing F, X and Aginine
- Other therapeutic agents: STAMPs, xylitol, licorice extract, novel natural therapeutic substances…
- Potential Products: Mouth rinse, Candy, Sealant, Gel, Toothpaste, Prophylaxis Paste,…